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NORTH AMERICAN GRAPTOLITES.[1]

II. VERTICAL RANGE.

WITHOUT attempting to discuss at length the general aspects of this subject, attention may be directed to the following points:

1. The vertical range of the American species presents a complete parallel to the range in other countries. This parallel is not a general one only, but is exceedingly detailed, extending beyond the genera down to the species, which in each horizon correspond to those of the equivalent European horizon almost without exception, although of course not every European species occurs in America, or vice versa. Still the number of species common to the two sides of the Atlantic is surprising, and it will doubtless be increased by future research.

2. This detailed correspondence furnishes good ground for the expectation that eventually the American strata, like the European, will be mapped out, zone above zone, and for the hope that here, too, the graptolites may ultimately become one of the mainstays of stratigraphy. Much has of course yet to be done, but the peculiar associations of species in several collections so nearly parallel those which abroad characterize particular zones, that it is difficult to believe that here they have a different significance.

3. The extent of the range of the group as a whole, is unprecedented, as it extends from the Cambrian to and into the Carboniferous.

4. A striking peculiarity of the American fauna is the almost entire absence of the great European family of the *Monograptidæ*

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[1] Continued from THE JOURNAL OF GEOLOGY, Vol. IV., No. 1, January-February, 1896, p. 102.

with its three genera and more than 100 good species. In America only one genus and two species are known, one of them from Arctic America. One reason for this absence is undoubtedly the predominance of limestone and the scarcity of shale in most of our Upper Silurian formations, but it cannot but be suspected that future collections may yield some of that wealth of forms to which European graptolithologists have long had access.

CAMBRIAN.

Genus and Species	Lower	Middle	Upper						
			St. John (N. B.) Group (Div. 3.)[2]			Canada[4]			
	Georgia Shales (Vermont)[1]	Acadia Group (St. John, N. B.)[2]	b	c	c'	Oldhamia zone (purple Farnham shales)[6]	Dictyonema-Olenidae zone	Dictyonema flabelliforme zone (Cape Rosier)	Upper Mississippi Valley[5]
Phyllograptus	?								
? cambrensis	W								
Bryograptus			▬	▬				▬	
lentus				M[3]					
multiramosus								G	
patens			M	M[3]					
? retroflexus?			M[3]						
spinosus			M	M[3]					
sp.								L	
Clonograptus								L	
Dichograpsus				▬					
proximatus				M[3]					
Staurograpsus								L	
Climacograptus	?								
? emmonsi	W								
Protograptus		▬							
alatus		M							
Dendrograptus		?							▬
hallianus									P
? primordialis		M							
Callograptus				▬					
sp.				M[3]					
Dictyonema			▬	▬	▬		▬	▬	
flabelliforme			M[3]	M[3]			L	L	
acadicum			M	M	M				
confertum (Lnrs *MS.*)?			M	M					
norvegicum?				M	M				
Oldhamia (like O. radiata)						L			
Olenidae							L		

NOTES TO CAMBRIAN TABLE.

G signifies *fide* R. R. Gurley.

L signifies *fide* Charles Lapworth.[4]

M signifies *fide* G. F. Matthew.[2]

P signifies *fide* H. A. Prout.[5]

W signifies *fide* C. D. Walcott.[1]

[1] Walcott, Bull. 30, U. S. Geol. Surv., 1886, pp. 92–94.

[2] Matthew, List of Fossils found in the Cambrian rocks in or near Saint John, N. B., 1892, p. vi.

[3] Matthew, Trans. N. Y. Acad. Sci., 1895, pp. 262–273, Pls. XLVIII.–XLIX.

[4] Lapworth, Trans. Roy. Soc. Can. for 1886, V, sect. IV., p. 168.

[5] Prout, Amer. Journ. Sci., 1851, XI., p. 187.

[6] The shales are of Sillery age (*fide* Ells; see Walcott, Proc. U. S. Nat. Mus., 1894, XVII., p. 313) and should probably be placed at a higher level in (perhaps at the summit of) this table (*cf.* Walcott, Amer. Jour. Sci., 1890, XXXIX., pp. 112–114.)

ORDOVICIAN.

Genus and Species.	Lower.												Middle [12]					Upper [12]					
	Calciferous. [1]								Chazy [11]					Lower *Dicellograpsus* Zone.		Upper *Dicellograpsus* Zone.		Utica Horizon				Lorraine Horizon	
	Lower Zones			? Intermediate		Upper Zones																	
	St. John Group (summit)[2]	Gros Maule [3]	Main Pt. Levis Zone [1]	Miscellaneous [4]	Phyllograptus anna Zone [5]	Pt. Levis [1]	Arkansas	Nevada [1]	Nevada	Mystic, Canada	Kicking Horse Pass	Dease River, B. C.	Trenton Limestone	New York and Canada	Arkansas [13]	Cove Fields, etc.[14]	Magog, Canada	Mohawk Valley	Lake St. John	Lower Cincinnati	Lower Maquoketa	Upper Maquoketa	Lorraine Shales (New York)
Phyllograptus			▬		▬		▬	▬															
angustifolius																							
anna	....	....	....	....	H L	....	G	G															
ilicifolius																							
" mancus (Lapworth var. *MS.*[6])	....	....	L G																				
loringi																							
typus	....	....	....	....	....	....	? G																
sp. indet.	....	....	....	....	....	....	....	G															
Schizograptus			▬				?																
amii (Lapworth *MS.*[6])	....	....	L G																				
rarus (Lapworth *MS*[6])	....	....	L G																				
? sp.	....	....	....	....	....	....	G																
Goniograptus M'Coy																							
thureaui selwyni	....	....	....	A																			
Dichograpsus	▬	▬	▬			▬	▬																
abnormis	....	....	....	....	....	G																	
flexilis	M	....	G																				
logani	M	....	....	....	....	G																	
milesi[7]																							
octobrachiatus	....	....	G																				
octonarius	....	H																					
ramulus	....	....	G																				
remotus	....	....	G																				
rigidus	....	....	G																				
sp.	....	....	....	....	....	....	G																
Tetragrapsus	▬	▬	▬		▬	▬	▬																
acanthonotus	....	....	G																				
alatus																							
approximatus	....	....	G																				
bigsbyi	....	....	G																				
crucifer																							

ORDOVICIAN—*Continued.*

GENUS AND SPECIES	Lower												Middle[12]					Upper[12]					
	Calciferous[1]								Chazy[11]					Lower *Dicellograpsus* Zone		Upper *Dicellograpsus* Zone		Utica Horizon				Lorraine Horizon	
	Lower Zones			? Intermediate		Upper Zones																	
	St. John Group (summit)[2]	Gros Maule[3]	Main Pt. Levis Zone[1]	Miscellaneous[4]	Phyllograptus anna Zone[5]	Pt. Levis[1]	Arkansas	Nevada[1]	Nevada	Mystic, Canada	Kicking Horse Pass	Dease River, B. C.	Trenton Limestone	New York and Canada	Arkansas[13]	Cove Fields, etc.[14]	Magog, Canada	Mohawk Valley	Lake St. John	Lower Cincinnati	Lower Maquoketa	Upper Maquoketa	Lorraine Shales (New York)
Tetragrapsus—*cont'd.*																							
denticulatus			G																				
fruticosus			G		H L																		
headi																							
hicksi				A																			
quadribrachiatus	M		G																				
serra		H	G		H	G	G																
sp.?	M																						
Holograptus			?		?																		
? richardsoni			G		H																		
Didymograpsus	—	—	—		—	—	—	—	—	—	—	—		—	—			?[30]					
arcuatus																							
bifidus					H	G			G[11]														
bipunctatus																							
caduceus							? G																
convexus														G									
? elegans														[18]									
sp. nov. near euodus					L						L												
extensus																							
extenuatus																							
hirundo (=constrictus)		H	G																				
indentus	M		G																				
murchisoni furcillatus				A																			
nitidus	M																						
patulus	M		L G																				
pennatulus																							
perflexus								G															
? rectus														[18]									
sagitticaulis												L		×	G								
serratulus														×	G			Wh[30]					
similis					H																		

ORDOVICIAN—*Continued.*

Genus and Species	Lower												Middle[12]					Upper[12]					
	Calciferous[1]								Chazy[11]					Lower *Dicellograpsus* Zone		Upper *Dicellograpsus* Zone		Utica Horizon				Lorraine Horizon	
	Lower Zones			? Intermediate		Upper Zones																	
	St. John Group (summit)[2]	Gros Maule[3]	Main Pt. Levis Zone[1]	Miscellaneous[4]	Phyllograptus anna Zone[5]	Pt. Levis[1]	Arkansas	Nevada[1]	Nevada	Mystic, Canada	Kicking Horse Pass	Dease River, B. C.	Trenton Limestone	New York and Canada	Arkansas[13]	Cove Fields, etc.[14]	Magog, Canada	Mohawk Valley	Lake St. John	Lower Cincinnati	Lower Maquoketa	Upper Maquoketa	Lorraine Shales (New York)
Didymograpsus—*cont'd.*																							
cf. superstes														L									
spp. nov.							? G							L									
sp. ("nar. thread like")	M																						
sp.? ("very nar.")	M																						
Clematograptus														▬									
multifasciatus														H L									
Nemagrapsus														▬	▬								
capilaris[8]														LG[15]									
Stephanograptus														▬									
crassicaulis														G									
exilis														L G									
gracilis														×	G								
surcularis														× G									
New form allied to Stephanograptus												L											
Amphigraptus														▬									
divergens														G									
Stenograptus (Lapworth *MS.*[6])			▬																				
speciosus (Lapworth *MS.*[6])			L G																				
Leptograptus														▬	▬			▬	▬	?			
annectans															? G			W G		? G			
flaccidus																			H				
subtenuis														× G									
? macrotheca			G																				
Azygograptus														?									
? walcotti														L G									
Dicellograpsus														▬	▬	L							
anceps														A									
divaricatus														×	G								
elegans															? G								
forchhammeri														A[16]									

ORDOVICIAN—*Continued.*

Genus and Species	Lower												Middle [12]					Upper [12]					
	Calciferous [1]								Chazy [11]					Lower *Dicello-grapsus* Zone		Upper *Dicello-grapsus* Zone		Utica Horizon				Lorraine Horizon	
	Lower Zones			? Intermediate		Upper Zones																	
	St. John Group (summit) [2]	Gros Maule [3]	Main Pt. Levis Zone [1]	Miscellaneous [4]	Phyllograptus anna Zone [5]	Pt. Levis [1]	Arkansas	Nevada [1]	Nevada	Mystic, Canada	Kicking Horse Pass	Dease River, B. C.	Trenton Limestone	New York and Canada	Arkansas [13]	Cove Fields, etc. [14]	Magog, Canada	Mohawk Valley	Lake St. John	Lower Cincinnati	Lower Maquoketa	Upper Maquoketa	Lorraine Shales (New York)
Dicellograpsus—*cont'd.*																							
gurleyi [17]	....	....	....	....	....	....	....	....	....	....	....	....	....	L G									
intortus	....	....	....	....	....	....	....	....	....	....	....	....	....	L	G								
" polythecatus	....	....	....	....	....	....	....	....	....	....	....	....	....	G									
rigidus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	G								
sextans	....	....	....	....	....	....	....	....	....	....	....	....	....	×	....	....	....	? [30]					
" tenuibrachiatus (*nom. nud.*)	....	....	....	....	....	....	....	....	....	....	....	....	....	L									
Dicranograptus														—	—	—	—	—		—			
cf. clingani	....	....	....	....	....	....	....	....	....	....	....	....	....	A									
dissimilaris	....	....	....	....	....	....	....	....	....	....	....	....	....	[18]									
furcatus	....	....	....	....	....	....	....	....	....	....	....	....	....	×									
? inequalis	....	....	....	....	....	....	....	....	....	....	....	....	....	[18]									
nicholsoni	....	....	....	....	....	....	....	....	....	....	....	....	....	? A	....	....	....	G L					
" arkansasensis	....	....	....	....	....	....	....	....	....	....	....	....	....	....	G	....	G						
" whitianus [19]																							
" parvangulus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	G								
" diapason	....	....	....	....	....	....	....	....	....	....	....	....	....	G									
ramosus	....	....	....	....	....	....	....	....	....	....	....	....	....	×	G	....	G	WhG	....	?G			
" rectus	....	....	....	....	....	....	....	....	....	....	....	....	....	L									
" spinosus (*nom. nud.*)	....	....	....	....	....	....	....	....	....	....	....	....	....	L	....	L							
" tardiusculus (*nom. nud.*)	....	....	....	....	....	....	....	....	....	....	....	....	....	L	....	? L							
Climacograptus								—			—	—		—	—	—	—	—		—			
antiquus	....	....	....	....	....	....	....	....	....	....	....	?L	....	L	G	....							
bicornis	....	....	....	....	....	....	....	....	....	....	....	....	....	×	G	L	G	WhG					
caelatus [9]	....	....	....	....	....	....	....	L G	....	....	L												
caudatus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	G						
" laticaulis	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	G						
cf. confertus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	A							
kamptotheca	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	G						
oligotheca	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	G						
phyllophorus [21]	....	....	....	....	....	....	....	....	....	....	....	....	....	G									

ORDOVICIAN—*Continued.*

Genus and Species	Lower												Middle[12]					Upper[12]					
	Calciferous[1]								Chazy[11]					Lower *Dicellograpsus* Zone		Upper *Dicellograpsus* Zone		Utica Horizon				Lorraine Horizon	
	Lower Zones			? Intermediate		Upper Zones																	
	St. John Group (summit)[2]	Gros Maule[3]	Main Pt. Levis Zone[1]	Miscellaneous[4]	Phyllograptus anna Zone[5]	Pt. Levis[1]	Arkansas	Nevada[1]	Nevada	Mystic, Canada	Kicking Horse Pass	Dease River, B. C.	Trenton Limestone	New York and Canada	Arkansas[13]	Cove Fields, etc.[14]	Magog, Canada	Mohawk Valley	Lake St. John	Lower Cincinnati	Lower Maquoketa	Upper Maquoketa	Lorraine Shales (New York)
Climacograptus—*cont'd.*																							
scalaris[9]																							
scharenbergi														L G		L	G						
typicalis																		G		U G			
wilsoni																	G						
Diplograpsis						▬	▬	▬			▬	▬	▬	▬	▬	▬	▬	▬	▬		▬		▬
angustifolius											L			×	G								
dentatus						G	G											[29]					
euglyphus												L		LG		? L							
foliaceus											L			×	G	L	G	Wh G					? G
" *mut.* amplexicaule										G			HG										
" basilicus (*nom. nud.*)																L							
" confertus (*nom. nud.*)																L							
" *mut.* laciniatus														[18]									
" platydens (*nom. nud.*)																L							
foliosus														[18]									
"folium His. (as of Nicholson)"[10]																							
hudsonicus[20]																							
inutilis						G																	
latior (*nom. nud.*)																							A
peosta[22]																					G		
" *mut.* perexcavatus														LA			? G						
putillus[22]																					G		
quadrimucronatus																			H				
ruedemanni Gurley, sp. nov.																		G					
stenosus																		G					
trifidus[23]															G								
truncatus																? L	? G						
whitfieldi														G	G								
sp.								G															

Genus and Species	Lower												Middle[12]					Upper[12]					
	Calciferous[1]								Chazy[11]				Trenton Limestone	Lower *Dicellograptus* Zone		Upper *Dicellograptus* Zone		Utica Horizon				Lorraine Horizon	
	Lower Zones			? Intermediate		Upper Zones																	
	St. John Group (summit)[2]	Gros Maule[3]	Main Pt. Levis Zone[1]	Miscellaneous[4]	Phyllograptus anna Zone[5]	Pt. Levis[1]	Arkansas	Nevada[1]	Nevada	Mystic, Canada	Kicking Horse Pass	Dease River, B. C.		New York and Canada	Arkansas[13]	Cove Fields, etc.[14]	Magog, Canada	Mohawk Valley	Lake St. John	Lower Cincinnati	Lower Maquoketa	Upper Maquoketa	Lorraine Shales (New York)
Cryptograptus							▬	▬			▬	▬		▬	▬	▬	▬						
antennarius							G																
tricornis							G	G		G	L	L		X	G	L	G						
Lasiograptus														▬	▬		▬						
bimucronatus														L									
mucronatus														X	G		G						
Glossograptus								▬		▬	▬			▬	▬								
arthracanthus														[18]									
ciliatus								L G			L	L		G L	G								
setaceus														[18]									
spinulosus											L			H	G								
Reteograptus	▬													▬					▬				
eucharis																			H				
geinitzianus														X G									
tentaculatus	? M																						
Trigonograpsus			?			▬	▬																
ensiformis			? G			G	G																
Clathrograptus														▬									
cuneiformis														L									
Dendrograptus							▬								▬		▬	▬		▬			
arundinaceus[24]																		H G					
compactus																		W G					
diffusus																							
divergens																							
erectus																							
flexuosus																							
fruticosus																							
gracillimus																				Lq			
gracilis																							
cf. serpens							G																
simplex																		W G					

ORDOVICIAN—*Continued.*

Genus and Species	Lower												Middle[12]					Upper[12]					
	Calciferous[1]								Chazy[11]					Lower *Dicellograptus* Zone		Upper *Dicellograptus* Zone		Utica Horizon				Lorraine Horizon	
	Lower Zones			? Intermediate		Upper Zones																	
	St. John Group (summit)[2]	Gros Maule[3]	Main Pt. Levis Zone[1]	Miscellaneous[4]	Phyllograptus anna Zone[5]	Pt. Levis[1]	Arkansas	Nevada[1]	Nevada	Mystic, Canada	Kicking Horse Pass	Dease River, B. C.	Trenton Limestone	New York and Canada	Arkansas[13]	Cove Fields, etc.[14]	Magog, Canada	Mohawk Valley	Lake St. John	Lower Cincinnati	Lower Maquoketa	Upper Maquoketa	Lorraine Shales (New York)
Dendrograptus—*cont'd.*																							
striatus																							
tenuiramosus																		W G					
unilateralis																	G						
spp. indet. 3 (fragments)															1 G		2 G						
Callograptus		—	—																				
elegans		H	G																				
salteri		H	G																				
Dictyonema	—			—		—							—	—	—		—						
grande																							
cf. homfrayi				A																			
irregulare						G																	
murrayi																							
neenah													[25]										
obovatum															G								
perexile	M																						
quadrangulare	M																						
robustum																							
spp. incert.														G			G						
Desmograptus			—																				
macrodictyon			G																				
Ptilograptus			—																				
geinitzianus			G																				
plumosus			G																				
Thamnograptus								—						—	—		—						
anna								G															
barrandi														× G	G		G						
capillaris														H									
typus														H G									
Inocaulis																				—			
arbuscula																				U			

ORDOVICIAN—*Continued.*

Genus and Species	Lower												Middle[12]					Upper[12]					
	Calciferous[1]								Chazy[11]					Lower *Dicellograptus* Zone		Upper *Dicellograptus* Zone		Utica Horizon				Lorraine Horizon	
	Lower Zones			? Intermediate		Upper Zones																	
	St. John Group (summit)[2]	Gros Maule[3]	Main Pt. Levis Zone[1]	Miscellaneous[4]	Phyllograptus anna Zone[5]	Pt. Levis[1]	Arkansas	Nevada[1]	Nevada	Mystic, Canada	Kicking Horse Pass	Dease River, B. C.	Trenton Limestone	New York and Canada	Arkansas[13]	Cove Fields, etc.[14]	Magog, Canada	Mohawk Valley	Lake St. John	Lower Cincinnati	Lower Maquoketa	Upper Maquoketa	Lorraine Shales (New York)
Buthograptus[26]													▬										
laxus													H										
Protovirgularia														▬									
dichotoma														? G									
Corynoides														▬		▬	▬						
calicularis														A		L	G						
Dawsonia			▬											▬		▬				▬			
acuminata																							
campanulata														A		A							
monodon			G																				
rotunda																							
tenuistriata																							
tridens			G																				
spp. 3 or 4 (Ulrich *MS*)																				U G[27]			
sp.														A									
Caryocaris			▬				▬	▬															
curvilatus			G					G															
oblongus			G																				
wrightii							G	L G															
Megalograptus																				▬			
welchi[28]																				Mi			
Phycograptus														▬									
brachymera														G									
macromera														G									
laevis														G									

NOTES TO ORDOVICIAN TABLE.

× signifies range admitted by all observers.
A signifies *fide* H. M. Ami.
G signifies *fide* R. R. Gurley.
H signifies *fide* James Hall.
L signifies *fide* Charles Lapworth.
M signifies *fide* G. F. Matthew.
Mi signifies *fide* S. A. Miller.
U signifies *fide* E. O. Ulrich.
W signifies *fide* C. D. Walcott.
Wh signifies *fide* R. P. Whitfield.

[1] *Calciferous*—The table given here is the result of a study of a considerable quantity of material from four American localities, as follows:

(*a*) The Point Levis shales. Two collections were examined. The first—from the main zone—was a very large one, containing a number of characteristic species, among which *Dichograpsus flexilis* and *Phyllograptus ilicifolius var.* were conspicuous. They occur in black shale.

(*b*) The second and smaller collection from the Point Levis shales was from a hard ringing iron-gray shale, lithologically quite different from the much softer, black shale of the first collection; locality, 1⅛ miles north of the East Railway Station, Levis, Canada. As will be seen from the table, the fauna was strikingly different from that found in the softer, black shale. It was remarkable not so much for the species present (though the *Diplograpsidæ* seem highly characteristic), *as for those absent*. Indeed, it is hardly possible to examine a fragment of the black shale without finding a number of species which appear never to occur in the hard gray shale.

Analogy with British stratigraphy suggests that the difference is one of horizon and this view is reinforced by an examination of collections from the Calciferous beds in Nevada and Arkansas, the fauna of which agrees in a general way with that of the hard, gray Point Levis shale, and differs widely from that found in the black shale in the same locality. Further, as in Europe, so in Nevada, *Didymograpsus bifidus* marks a distinctly higher horizon.

Perhaps intermediate faunas (implying intermediate horizons) may exist. Some of those given by Ami appear to indicate that such is the case (see below), but I think the main divisions will not thereby be obscured. The species whose horizons are indicated in the table are those which I have myself identified. The exact ranges of the others are unknown, being merely Calciferous generally.

(*c*) A large collection from the Piñon Range, at the crossing of the Eureka and Palisade Railroad, at Summit, Nevada; collector, C. D. Walcott. This collection shows some very interesting and unique features, notably, the presence of *Phyllograptus* entirely unaccompanied by any traces of *Tetragrapsus* or more highly compound dichograptid genera, the presence of *Climacograptus* and *Glossograpsus*, and the extreme profusion of individuals of *Caryocaris* which amount to more than half the entire number of specimens.

(*d*) A rather small collection from Arkansas, in which, however, a number of Calciferous species could be made out.

From a general survey of the above collections, we may, I think, suspect that several species imply a higher horizon than the main (*Dichograpsus flexilis*) zone. I should at present name here (questioningly): *Phyllograptus anna*, the *Diplograpsidæ* generally, *Glossograpsus*, *Dictyonema irregulare*, *Thamnograptus anna*.

That this classification by no means exhausts the zone problem of our Calciferous, may be inferred from the fact that other collections imply in the peculiar association of species exhibited at least two other horizons. On them I am not, however, at present prepared to report in detail, and will only say that in one *Phyllograptus typus* (which seems to be absent from the main zone, the genus being there represented by great numbers of *P. ilicifolius mancus*, Lapw. *MS.*), is the dominant species, and that the other is characterized mainly, if not almost entirely by several *Dictyonema* species which are absent from the main Point Levis zone. This last feature (that the zones are for the most part *mutually complementary*) is a striking and important one.

Finally, I may say that the table here given, classifies every species, I believe, ever recorded, except certain faunas reported by Mr. Ami (in Ells, Ann. Rep. Geol. Surv. Can. for 1887 (1889), Pt. K). The twelve Calciferous faunas reported were not classified into zones. Careful study of them leads me to think that they harmonize fairly well with the division here suggested, viz., into a lower zone rich in (especially dichograptid) species, and an upper zone with a much less rich fauna in which the diplograptid element is conspicuous.

Newly introduced species whose horizon is not clearly defined are listed in the miscellaneous column.

[2] Stage *d* of Division 3 of Matthew (reference, Note 2, Cambrian table).

[3] Tabulated from Hall (Canad. Org. Rem., Dec. II., 1865, pp. 68–142).

[4] See last paragraph of Note 1.

[5] Tabulated from Hall (*loc. cit.*, in Note 3, above), and from Lapworth (Trans. Roy. Soc. Can., 1886, V., Sect, IV., p. 184).

[6] Identification by Lapworth from specimens sent (in *MS.* report to author).

[7] From a loose bowlder.

[8] This species *fide* Ami (Bull. Geol. Soc. Amer., 1891, II, table p. 495), occurs in the Calciferous. On p. 492 (the only list in the paper which contains this species), to the specific diagnosis is added a " ? " In this connection I may say that I identified a specimen in the Nevada collection (the same horizon) as *capilaris* Emmons, but later, after obtaining Emmons' species at Stockport, found the Nevada specimen to be *Thamnograptus anna* Hall.

[9] The form found by Mr. Ami (Ann. Rep. Can. Surv. for 1887 (1889), p. 50K) in the (upper) Calciferous, and referred by him to *Climacograptus scalaris* Hisinger, is in all probability, this species. It could not be *C. scalaris*, inasmuch as that species is nowhere else found below the very summit of the Ordovician (Brachiopod schists of Sweden; and, as var. *normalis* Lapw., at base of Upper Silurian in Britain). See also note 21.

[10] This species, listed by Ami (in Ells, *loc. cit.*, p. 50K), can hardly be *Cephalograpsus folium* His., as that species is known only in the highest beds of the Ordo-

vician (Upper Graptolite schists of Sweden). In the Upper Calciferous shales of Nevada, many specimens of *Phyllograptus* occur, some of which, not being well enough preserved to show all the *Phyllograptus* structure, present a deceptive *folium* aspect. Whether this is the explanation of Ami's *folium* or not I cannot say, as I have not seen the specimens.

[11] *Chazy.*—Little is known in regard to the graptolite fauna of this horizon. In Nevada, *Didymograpsus bifidus* Hall, occurs in strata certainly supra-Calciferous and probably Chazy horizon (*fide* oral statement of C. D. Walcott.)

In a small collection from the Chazy at Mystic, Canada, a few poorly preserved (mostly fragmentary) graptolites were seen. Only *Diplograpsis foliaceus* Murch. (*mut. amplexicaule* Hall), and *Cryptograptus tricornis* Carr., could be determined with any certainty. Some *Didymograpsus* fragments of two species completed the collection.

Further, somewhere between the *Dichograpsus* fauna characteristic of the Calciferous, and the *Dicellograpsus* faunas, characteristic of the (certainly pre-Utican and probably) Trenton, are to be placed the faunas occurring in the beds at Kicking Horse (Wapta) Pass, Rocky Mountains (Lapworth, 1886, Ann. Rep. Geol. Surv. Can., II., pp. 22D–24D; also Science, 1887, IX., p. 320), and those along Dease River, British Columbia (Lapworth, 1889, Ann. Rep. Geol. Surv. Can., III., pp. 94B, 95B; also Can. Rec. Sci., III., pp. 141, 142). Approximately at least, these beds are of the same age, and in a general way, and as a diagnosis by exclusion, may be said to be Chazy.

[12] *Trenton-Lorraine.*—Besides faunas already recorded, the following collections have been studied:

Lower *Dicellograpsus* zone; Lower Falls, Kinderhook Creek, near Stockport, N. Y. About three tons of excellent material collected by the author. Also a rather small collection from Schodack Landing, N. Y.

Upper *Dicellograpsus* zone: Large collection from Magog, Canada.

Graptolite Zones.—As remarked by Lapworth (Trans. Roy. Soc. Can for 1886, V., Sec. IV., p. 176), the Trenton limestone should, in all probability be regarded as a deep-water deposit. Its age not improbably embraces both the Lower and Upper *Dicellograpsus* zones. Briefly the evidence is:

(*a*) At Schodack Landing, Rensselaer county, N. Y., Ford (Amer. Jour. Sci., 1884, XXVIII., p. 206) found the Lower *Dicellograpsus* fauna associated with a brachiopod fauna which, as regards age, may be anywhere from Trenton to Lorraine, but cannot be pre-Trenton.

(*b*) In spite of assertions to the contrary, the graptolite faunas of the *Dicellograpsus* zones are not only identical with, but are strongly contrasted to those of the Utica shale proper (that of the Mohawk Valley). And Lapworth's statement that, with the asserted exception of five species, not a shadow of palæontological evidence has yet been adduced to show that these Norman's Kill or Marsouin rocks are newer than the Trenton," is fully justified (*loc. cit.*, p. 171).

(*c*) Parallelism with European (principally British) stratigraphy, strongly confirms the order of superposition suggested by the faunas, viz., in ascending order:

$$\left.\begin{array}{l}\text{Lower Dicellograpsus zone}\\ \text{Upper Dicellograpsus zone}\end{array}\right\} = \text{Trenton (?)}$$

Utica.

If now the *Dicellograpsus* zones cannot be pre-Trenton, and must be sub-Utican, by exclusion they only can only be Trenton, and as a rough approximation we may say lower and middle Trenton respectively. Following them, of course, are the Utica and Lorraine horizons.

[13] Contrary to the opinion formerly expressed as the result of insufficient study, the Arkansas beds belong rather to the Lower than to the Upper *Dicellograpsus* zone. To show this, the following table is given showing the range of the species as ascertained in New York and Canada:

ARKANSAS SPECIES	Lower Dicellograpsus Zone	Upper Dicellograpsus Zone	Utica	Supra Utican
Didymograpsus sagitticaulis	×			
" serratulus	×			
Stephanograptus gracilis	×			
Leptograptus (like annectans)				
Dicellograpsus rigidus	Gl			
" divaricatus	×			
" intortus	×			
" elegans	Var.	LH	UH	
Dicranograptus ramosus	×	×	×	
" nicholsoni			×	
" " parvangulus				
" " arkansasensis		×		
Climacograptus antiquus ?	×	Var.		
" bicornis	×	×	×	
Diplograpsis foliaceus	×	×	×	×
" trifidus				
" whitfieldi	×			
" angustifolius	×			
Cryptograptus tricornis	×	×		
Lasiograptus mucronatus	×	×		
Glossograpsus ciliatus	×			
Dictyonema obovatum				
Dendrograptus sp				
Thamnograptus barrandi	×	×		

The following abbreviations mean: Gl. Glenkiln; LH. Lower Hartfell; UH. Upper Hartfell. The species so marked are known in America only in Arkansas, and the comparison is with their ascertained foreign range in strata equivalent to those represented in the column.

[14] Zone first noted by Lapworth (Trans. Roy. Soc. Can. for 1886, V., Sec. IV., p. 172), as "Zone without *Coenograptus gracilis.*" The collections referred here were from the Cove Fields, from St. John Market, Quebec, and from the north side of the Island of Orleans. Subsequently Ami (Ann. Rep. Geol. Surv. Can. for 1887, p. 46K), found *Stephanograptus* ("*Coenograptus;*" species not stated) in this zone.

[15] In the black shales of the Lower *Dicellograpsus* zone in the Hudson Valley, I have found typical specimens of this species. I believe it does not occur at other horizons. Ami (Ann. Rep. Geol. Surv. Can. for 1887, p. 53K ; consult also 51K, where the same zone appears to be represented), reports it, however, from a horizon certainly Calciferous, and apparently Upper Calciferous. (See also Note 8.)

[16] It is doubtful whether this is Geinitz's species. More probably it is referable to the next, as there appears to be but one species closely allied to Geinitz's at this horizon, and that one Prof. Lapworth (*MS.* report to author) says is distinct. *Cf.* next.

[17] Probably Ami's *D. forchhammeri* is this species. *Cf.* preceding note.

[18] As suggested by Lapworth (Geol. Distrib. Rhabdophora, p. 31), the following species described by Emmons (*American Geology*, 1856. Pt. 2, pp. 104–111), are probably referable to this zone.

Didymograpsus ? ("Monograpsus") elegans Emm.
" ? ("Monograpsus") rectus Emm.
Dicranograptus ? ("Cladograpsus") inequalis Emm.
" ("Cladograpsus") dissimilaris Emm.
Diplograpsis foliaceus Murch.
(as D. dissimilaris Emm.)
(as D. rugosus Emm.)
(as D. obliquis Emm.)
(as D. laciniatus Emm.)
foliosus Emm.
Glossograpsus arthracanthus.
" setaceus Emm.

Further, Didymograpsus ? ("Monograpsus") rectus Emm., from "Columbia county (N. Y.), in the Taconic Shales," probably belongs at this horizon, which is very well developed in Columbia county. The species presents every appearance of an accidental juxtaposition of two fragments.

[19] As an appendix to the table, the following fauna reported by Dr. C. A. White, (Rep. Wheeler Surv, 1875, IV., pp. 62–66), from strata five miles north of Belmont, Nevada, may be noted. The identifications have been made after a study of the types in the National Museum. As far as the stratigraphic value of the species is concerned, the horizon might be anywhere from the Lower Dicellograpsus zone to the Utica, both inclusive.

WHITE'S NAME	IDENTIFICATION
Graptolithus (Climacograptus) ramulus.	Dicranograptus nicholsoni whitianus.
Graptolithus (Diplograptus) pristis Hall ?	Diplograpsis foliaceus.
Graptolithus (Diplograptus) hypniformis.	Diplograpsis foliaceus ?
Graptolithus (Diplograptus) quadrimucronatus.	Diplograpsis sp.?

[20] From a loose slab carried from its original site by commerce ; age, "the Hudson River Group."

[21] The "*Climacograptus scalaris*, Hisinger, var. *normalis*, Lapworth," of Ami (Ann. Rep. Geol. Sur. Can. for 1887 (1889), p. 78K ; Bull. Geol. Soc. Amer., 1891, II., p. 496), is almost certainly this species, as this is the only one at this horizon to which it could refer. Hall's *scalaris* of 1847 consists of four species. *Cf.* Note 9.

[22] "Hudson River Group of Iowa" (Hall).

[23] Cf. *D. foliaceus calcaratus*, Lapw. (in Armstrong, Young & Robertson's Cat. West Scottish Foss., p. 6, Pl. II., Fig. 30.) The latter is a Hartfell species. The identity of the two forms can hardly be asserted at present as Lapworth's *calcaratus*, rests solely upon the figure of a basal fragment. Still, had I had access to his figure, I should not have described *D. trifidus.*

[24] Entirely overlooked by cataloguers. Horizon, from label on type in American Museum of Natural History, New York City. Locality, Turin, Lewis county, N. Y.

[25] Trenton Limestone of Wisconsin.

[26] I suspect that, as Prof. Whitfield (Mem. Amer. Mus. Nat. Hist., N. Y., 1895, I., pp. 40–41) believes, this genus is non-graptolitic.

[27] One species from the Trenton of Minnesota; three species from the Cincinnati group at Cincinnati, Ohio; all in the collection of Mr. Ulrich.

[28] "Lower beds, Cincinnati Group" (Ulrich; label).

[29] *Diplograpsis ruedemanni* Gurley, sp. nov.

(*Diplograptus pristiniformis*, Ruedemann, 1895, Amer. Jour. Sci., pp. 453–455, Figs. 2, 3; *Diplograpsis ruedemanni* Gurley, *nom. nud.*, supra, p. 78).

Entire polypary consisting of a number of diprionidian stems ("polyparies" as formerly understood) originating in and radiating from a common central "disk" (Ruedemann). Diprionidian stems quite small, the greatest length observed (in incomplete specimens) 7^{mm}. Maximum breadth 1.5^{mm} (a single stout specimen reached 1.75^{mm}). Thecæ cylindrical, the breadth practically the same throughout and their axis practically straight; 38–50 in 25^{mm} as nearly as determinable (ranging from 2 in 1^{mm}, 7 in 4^{mm}, 5 in 3^{mm}, to 3 in 2^{mm}). Aperture in scalariform impression, squarish, 0.6–0.8^{mm} on a side; margin straight, in the large majority of specimens appearing perpendicular to virgula, thus producing a deep indentation, a shorter overlap ($\frac{1}{3}$–$\frac{2}{5}$), and an acute "denticle." But I believe (the material not perfectly satisfactory) that the real condition is: margin inclined to virgula on proximal ("distal") side about 60° (say 55°–65°), and an overlap of ½. Inclination of the thecæ on proximal ("distal") side to virgula, 40°.

I know but six Diplograpses with as many thecæ in 25^{mm}, viz.: *D. sinuatus* Nich., and *D. insectiformis* Nich., both Upper Silurian species; *D. confertus* Nich., whose breadth (8^{mm}) alone suffices to exclude it: *D. putillus* (Hall), which has 34–38 thecæ in 25^{mm} without overlap; *D. minimus* Carr., with which the present species will bear comparison; and *D. hudsonicus* Nich. From the last *D. ruedemanni* differs in the form and amount of overlap of the thecæ and in lacking the spine on the lower lip of the aperture.

Horizon and locality.—Utica Shale, near Dolgeville, N. Y., dedicated to the discoverer, Dr. R. Ruedemann, of Dolgeville.

[30] *Fide* Whitfield (Rep. Wheeler Surv., 1875, IV., p. 19). I do not believe these genera occur in the Utica, and think with Lapworth, that the *Didymograpsus* was probably a *Leptograptus*. As in Britain the Glenkiln, so in America its equivalent, the Lower *Dicellograpsus* Zone, seems to mark the last appearance of the genus *Didymograpsus.*

SUPRA-ORDOVICIAN

Genus and Species	Upper Silurian		Devonian		Lower Carbon.
	Clinton	Niagara	Upper Heldbg.	Hamilton	Choteau
Diplograpsis? dubius[1]	SG				
Lomatoceras[2]	—				
clintonense	H G				
convolutum coppingeri[3]					
Gladiolites[4]	—				
venosus	HG				
Dendrograptus		—			
dawsoni		S			
dubius		S			
frondosus		S			
novellus		HG			
praegracilis		S			
ramosus		S			
spinosus		S			
Callograptus		—			
granti		S			
minutus		S			
multicaulis		S			
niagarensis		S			
Dictyonema	—	—	—	—	—
blairi					G
expansum		SG			
fenestratum			H		
gracile		S			
actinotum				HG	
pergracile		S			
pertenue	F				
retiforme		S			
scalariforme	F				
splendens					
tenellum		S			
websteri					
Desmograptus				—	
devonicus				HG	
Calyptograpsus		—			
cyathiformis		SG			
micronematodes		SG			
? radiatus		S			
subretiformis		SG			
Rhizograpsus		—			
bulbosus		S			
Acanthograpsus		—			
granti		SG			
pulcher		SG			
Inocaulis		—			
anastomotica		R			
bellus		HW			
cervicornis		SG			
diffusus		SG			

SUPRA-ORDOVICIAN—*Continued*

Genus and Species	Upper Silurian		Devonian		Lower Carbon.
	Clinton	Niagara	Upper Heldbg.	Hamilton	Choteau
Inocaulis—*cont'd.*					
divaricatus		H			
phycoides		SG			
plumulosus		HSG			
?problematicus		S			
ramulosus		S			
walkeri		SG			
Thamnograptus		?			
?bartonensis		SG			
Ptilograptus		▬			
foliaceus		SG			
Cyclograptus		▬			
rotadentatus		SG			

NOTES TO SUPRA-ORDOVICIAN TABLE.

F signifies *fide* A. F. Foerste.
G signifies *fide* R. R. Gurley.
H signifies *fide* James Hall.
HW signifies *fide* James Hall and R. P. Whitfield.
R signifies *fide* E. N. S. Ringueberg.
S signifies *fide* J. W. Spencer.

[1] I have examined a number of specimens of Spencer's *Phyllograptus dubius.* It is found merely as a black stain on the dark brown weathered Clinton shales. In regard to it I am willing to say only that the specimens appear to be mostly, and probably are entirely, Diplograptids. At least two (perhaps three or even more) species are present, as I found one which had the thecæ about 1^{mm} apart, and another about 1.5^{mm}. All the marginal fringing (which imparts somewhat the aspect of an *Inocaulis* branch) is due to weathering.

As regards the genus, there is little certainty, the specimens being very indistinct. *Phyllograptus*, of course, it cannot be and the present generic reference will probably prove to be the correct one.

[2] See p. 79.

[3] From Arctic America.

[4] See p. 79.

[5] Only two authors have, I believe, touched on the possible presence of Graptolites in the Carboniferous. Portlock (Geol. Rep. Londonderry, etc., 1843, pp. 321, 322) says: "The family of Graptolites has at present no known representative in the Carboniferous system; although a specimen from the mountain limestone, belonging to Captain Jones, M. P., has a strong resemblance to some of the double Graptolites."

And Hall (Pal. N. Y., 1859, III., p. 496) remarks that:

"The Graptolitidæ are therefore at this time clearly traced to the base of the Carboniferous system, and we may probably find allied genera to the close of the Palæozoic period."

In a collection presented to the U. S. National Museum, by Mr. R. A. Blair, of Sedalia, Mo., a *Dictyonema* was pointed out to me by Mr. Charles Schuchert, Curator of Palæontology. I have elsewhere described it as *D. blairi.* Associated with it are some poorly preserved specimens which bear, as Portlock would say, "a strong resemblance to some of the double Graptolites." I am, however, inclined to think it only a superficial resemblance, and pending further collections can assert the existence of no graptolite fauna other than *D. blairi.* Concerning that species there is no room for doubt.

COMPOUND AND SIMPLE FORMS IN THE DIPLOGRAPSIDÆ.

The recent paper of Ruedemann[1] unquestionably marks a real advance in our knowledge of *Diplograpsis* structure. Although I have not seen the specimens, I am prepared to accept the results described, as several years ago I saw a similar specimen on which a good many individuals of *Diplograpsis foliaceus* Murch., were so grouped as, on the doctrine of probabilities, to render it almost certain that they must have grown radiatingly from a common center. The specimen did not, however, show the common center. Since then I have seen a similar specimen in Professor Hall's collection which is still less equivocal. With better material Ruedemann has given a very interesting description of the structure, and has I think proved at least the following: That in two *Diplograpsis* species the stems ("polyparies," as we have been calling them) formerly regarded as simple and complete in themselves, are in reality only fragments of compound aggregates, relative to whose center the so-called "distally prolonged virgula" is in reality proximal, and the position of the sicula distal.

Such a discovery is to a certain extent revolutionary of our views of diplograptid structure, and is in importance comparable only to Hall's similar discovery of central connections for many of the numerous fragments previously lumped together as Monoprions and Monograpti on the easy "cells-on-one-side" character.

But (and this is the principal *raison d'etre* of this section) it seems to the writer that induction from these two *Diplograpsis* species to the *Diplograpsidæ* in general may be premature. And it is to the generalizations that Ruedemann has made (and very properly, indeed, from the standpoint of his material alone) that attention is directed.

The real question seems to be the magnitude of the taxonomic value of the discovery. In two *Climacograptus* species (*C. caelatus, C. phyllophorus*) an organ which from its position and character must be regarded as homologous with Ruedemann's "central disk" occurs. But in these species the "disk" is almost certainly simple, as it has a perfectly definite, uniform and constant outline. The compound form cannot then be taken as a family character. It may, however, prove of generic rank, *Diplograpsis* perhaps being distinguished by a compound, and *Climacograptus* by a simple disk. While it could be conceived as not even having this value, it seems to me not improbable that it may ultimately acquire this significance.

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[1] Amer. Jour. Sci., 1895, pp. 453–455, Figs. 1–5.

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U. S. GEOLOGICAL SURVEY.